

UNITED STATES APPLICATION

for

A METHOD AND SYSTEM FOR PROVIDING NETWORK  
CONNECTIVITY AND MOBILITY WHILE ROAMING

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A METHOD AND SYSTEM FOR PROVIDING NETWORK  
CONNECTIVITY AND MOBILITY WHILE ROAMING

BACKGROUND OF THE INVENTION

5       FIELD OF THE INVENTION

The present invention relates to the field of communications networks. More particularly, the present invention pertains to a method and system for providing network connectivity and mobility for a roaming client.

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RELATED ART

In a wireless communication network environment, a "client" node is associated to an "Access Point" (AP) in order to access a backbone or distribution communication network. The AP can be a hub or a switch in a wired network and the AP is commonly known as a Wireless Access-Point in a wireless LAN (Local Area Network). An AP has to be successfully connected to the backbone network before the client is able to log on to the backbone network.

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Figure 1 shows a communication network 50 in the prior art that shows a wireless communication network that is coupled to a backbone network via a wired connection, such as Ethernet. The wireless network consists of at least one access point (AP) connected to the wired network infrastructure and a set of wireless end stations, or clients, that are associated with that particular AP. The AP

acts as a bridge between the wired and wireless networks.

Additionally, a subnetwork, or subnet, may contain one or more APs along with their respective associate clients.

5       Figure 1 shows two access point wireless networks, AP-A network 110 and AP-B-network 150, in a communication network 50. In AP-A network 110, an access point AP-A 112 is wired to the backbone network 130. Various clients, A-1 114, A-2 116, on up to A-n 118 are connected to AP-A through a  
10 wireless connection to form AP-A network 110. Similarly, in AP-B network 150, an access point AP-B 152 is wired to the backbone network 130. Various clients, B-1 154, B-2 156, and on up to B-n 158 are connected to AP-B 152 through a wireless connection to form AP-B network 150. The network 50 could  
15 support and operate with more than two AP networks.

Additionally, two or more APs, such as AP-A 112 and AP-B 152 may form a subnetwork, where the subnetwork operates with a common network mask and common gateway. Moreover,

20 individual APs may be part of different subnetworks. For example, in Figure 1, AP-A 112 may be part of sub-network N1 with network mask M1 and Gateway G1, and AP-B 152 may be part of sub-network N2 with network mask M2 and Gateway G2.

25       An access point acts as the base station for the wireless network, aggregating access for multiple wireless end stations or clients onto the wired network, such as the

backbone network 130 in Figure 1. Each AP communicates with the clients over the wireless medium that is associated with that AP. For example, AP-A 112 communicates with its associate clients A-1 114, A-2 116, and on up to A-n 118.

- 5 The AP communicates with other APs and other nodes on the network 50 via the backbone network 130. A function of the AP, among many others, is to relay network traffic from its associated clients. The destination of this traffic may be another end station in the same, or different, AP network, or
- 10 the destination may be a node on a wired LAN (such as ethernet) connected to the backbone network. The AP provides this relaying function for end stations simultaneously.

A problem arises where a client, such as a notebook with networking capabilities, roams from a first subnet to a second subnet. For example, a user operating the client notebook may bring the client notebook to another building location, that is located in a different subnet, for a meeting. The mobility of the client requires the connection/disconnection or association/dissociation to occur between different APs from time to time. The challenge here is to have the various APs and the client communicate intelligently such that the network connection appears to be radically simple to the user throughout the client's mobility. When a client moves from a first subnet to a second subnet, its IP (Internet Protocol) address being used

in the previous subnet might not be valid in the second subnet.

- Additionally in the wireless LAN world, a client may
- 5 have to associate with another AP in a second subnet even though the client hasn't physically moved. This may be due to a failure of the association with the original or first AP. The connection status of the AP to the backbone is commonly not reported to the user when the AP-backbone
- 10 connection fails, leaving the user uninformed of its loss of transmission.

There are several possible scenarios where a client may experience loss of connection from the backbone network 130.

- 15 For example, looking at Figure 1, assume that we have a client A-2 116 and several AP's, namely AP-A 112, AP-B 152, on up to AP-n (not shown). Further, assume that AP-A 112 along with AP-A network 110 belong to subnetwork N1 (not shown) with network mask M1 and Gateway G1, and AP-B 152
- 20 along with AP-B network 150 belong to subnetwork N2 (not shown) with network mask M2 and Gateway G2 as in Figure 1.

- First, if the client A-2 116 roams or disconnects/reconnects with its associated AP-A 112, there
- 25 may be a loss of connection from the backbone network 130. Initially, the client is within the service area of AP-A 112. After boot up, the client will send out a DHCP (Dynamic Host

configuration Protocol) request and receive one IP address IP1 associated with subnet N1, network mask M1, and Gateway G1. Subsequently, the client may move around, roam to or connect with another AP in another subnet, such as AP-B 152  
5 in subnet N2. If the client is not aware of the switch to AP-B 152 and uses the same IP1 which is not within subnet N2, Gateway G2 will not forward packets sent by the client whose default gateway is G1. In most cases, N1 and N2 are different, that is AP-A 112 and AP-B 152 reside on different  
10 subnets.

Second, in the above example, when AP-A 112 loses its backbone connection, a resulting loss of connection occurs between the client A-2 116 to the backbone connection 130.  
15 In general, if an AP's link to the backbone is lost, its connected or associated clients will have no knowledge of such network failure and the associated clients will have to wait for the network administrator to pinpoint the problem and fix it. If it's a wireless AP, during this downtime period, any new wireless client that roams to this AP will not be able to connect to the backbone network even though the client successfully associates with the AP.  
20 Additionally, the new wireless client would not know that there is not a connection between the AP and the backbone connection 130.  
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Thus, there is a need for a more efficient system for monitoring connectivity to a communication network, especially when a client roams throughout a communication network from one subnet to another subnet.

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## SUMMARY OF THE INVENTION

The present invention provides a method and system for providing network connectivity and mobility for a roaming client. Also, the present invention provides a method and 5 system that achieves the above accomplishment and which also provides a better mutual information exchange protocol between clients and access points in a dynamic networking environment.

Specifically, in one embodiment of the present invention, 10 an access point (AP) has the capability of sending the AP connection and network status information, such as its own IP address, subnet mask, and gateway information, to a client when that client associates with the AP, or when the AP's network status or configuration changes.

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Furthermore, the connection and network status information of an AP in relation to its backbone network is provided to the clients associated with the AP by means of a smart agent and an associated protocol installed upon the AP. The smart agent is 20 capable of monitoring the AP link status to the backbone network and where applicable the capability to capture the TCP/IP information.

The effect of the invention is to provide a radically 25 simple user experience in networking connectivity and mobility in both wired and wireless network infrastructures. The invention provides an improved mutual information exchange

protocol between clients and AP's in a dynamic networking environment.

These and other objects and advantages of the present  
5 invention will no doubt become obvious to those of ordinary  
skill in the art after having read the following detailed  
description of the preferred embodiments which are illustrated  
in the various drawing figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a block diagram of a communication network environment in accordance with one embodiment of the present invention.

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Figure 2 is a schematic diagram of an exemplary computer system used to perform steps in providing network connectivity and mobility for a roaming client over a communication network, in accordance with one embodiment of the present invention.

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Figure 3 is a sample packet format in a layer 2 protocol to exchange information between an access point and its associated client in accordance with one embodiment of the present invention.

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Figure 4 is a flow chart of steps performed for dynamically providing network connectivity and mobility for a roaming client over a communication network.

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The drawings referred to in this description should be understood as not being drawn to scale except if specifically noted.

## DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to the preferred embodiments of the present invention, a method and system for providing network connectivity and mobility for a roaming client, examples of which are illustrated in the accompanying drawings. While the invention will be described in conjunction with the preferred embodiments, it will be understood that they are not intended to limit the invention to these embodiments.

On the contrary, the invention is intended to cover

10 alternatives, modifications and equivalents, which may be included within the spirit and scope of the invention as defined by the appended claims. Furthermore, in the following detailed description of the present invention, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be recognized by one of ordinary skill in the art that the present invention may be practiced without these specific details. In other instances, well known methods, procedures, components, and circuits have not been described in detail as not to 15 unnecessarily obscure aspects of the present invention.

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## NOTATION AND NOMENCLATURE

Some portions of the detailed descriptions which follow are presented in terms of procedures, steps, logic blocks, 25 processing, and other symbolic representations of operations on data bits that can be performed on computer memory. These descriptions and representations are the means used by those

skilled in the data processing arts to most effectively convey the substance of their work to others skilled in the art. A procedure, computer executed step, logic block, process, etc., is here, and generally, conceived to be a self-consistent

5 sequence of steps or instructions leading to a desired result.

The steps are those requiring physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and

10 otherwise manipulated in a computer system. It has proven convenient at times, principally for reasons of common usage, to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, or the like.

15 It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the following discussions, it is appreciated that

20 throughout the present invention, discussions utilizing terms such as "accessing" "processing" or "computing" or

"translating" or "calculating" or "determining" or "scrolling" or "displaying" or "recognizing" or the like, refer to the action and processes of a computer system, or similar

25 electronic computing device, that manipulates and transforms data represented as physical (electronic) quantities within the computer system's registers and memories into other data

similarly represented as physical quantities within the computer system memories or registers or other such information storage, transmission or display devices.

5 Referring to Figure 2, portions of the methods and systems for providing network connectivity and mobility for a roaming client are comprised of computer-readable and computer executable instructions which reside, for example, in computer-usable media of a computer system, such as that in an access  
10 point. Figure 2 illustrates an exemplary computer system 100 used to perform the dynamic exchange of information between an access point and its associated client in accordance with embodiments of the present invention. It is appreciated that system 100 of Figure 2 is exemplary only and that the present  
15 invention can operate within a number of different computer systems including general purpose networked computer systems, embedded computer systems, and stand-alone computer systems. Additionally, computer system 100 of Figure 2 is well adapted to having computer readable media such as, for example, a  
20 floppy disk, a compact disc, and the like coupled thereto. Such computer readable media is not shown coupled to computer system 100 in Figure 2 for purposes of clarity.

System 100 can include any computer-controlled software  
25 application for determining when to exchange information between an access point and its associated client, and what information to exchange. In general, computer system 100

comprises an address/data bus or other communication means 120 for communicating information, a central processor 101 coupled with the bus 120 for processing information and instructions, a volatile memory 102 (e.g., random access memory (RAM), static 5 RAM dynamic RAM, etc.) coupled with the bus 120 for storing information and instructions for the central processor 101, a non-volatile memory 103 (e.g., read only memory (ROM), programmable ROM, flash memory, EPROM, EEPROM, etc.) coupled with the bus 120 for storing static information and 10 instructions for the processor 101, a data storage device 104 (e.g., memory card, hard drive, optical disk, etc.) coupled with the bus 120 for storing information and instructions. System 100 of the present invention also includes an optional display device 105 coupled to the bus 100 for displaying 15 information to the computer user. System 100 also optionally includes an alphanumeric input device 106 including alphanumeric and function keys coupled to the bus 120 for communicating information and command selections to the central processor 101. System 100 also optionally includes a cursor 20 control device 107 coupled to the bus for communicating user input information and command selections to the central processor 101, and an Input/Output (I/O) device 108 coupled to the bus 120 for providing a communication link between computer system 100 and a network environment.

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In a wireless environment, the I/O device 108 may be a signal transmitter/receiver device 108, which is coupled to

bus 120 for providing a wireless radio (RF) communication link between computer system 100 and other wireless devices.

In one embodiment, computer system 100 of Figure 2  
5 includes host interface circuitry (not shown) coupled to bus 120. Host interface circuitry includes an optional digital signal processor (DSP) (not shown) for processing data to be transmitted or data that are received via transceiver 108. Alternatively, processor 101 can perform some or all of the  
10 functions performed by the DSP.

The display device 105 of Figure 2 utilized with the computer system 100 of the present invention may be a liquid crystal device, cathode ray tube, or other display device  
15 suitable for creating graphic images and alphanumeric characters recognizable to the user. The cursor control device 107 allows the computer user to dynamically signal the two dimensional movement of a visible symbol (pointer) on a display screen of the display device 105. Many implementations of the  
20 cursor control device are known in the art including a trackball mouse, joystick or special keys on the alphanumeric input device 105 capable of signaling movement of a given direction or manner of displacement. It is to be appreciated that the cursor means 107 also may be directed and/or activated  
25 via input from the keyboard using special keys and key sequence commands. Alternatively, the cursor may be directed and/or activated via input from a number of specially adapted cursor

directing devices or by other means such as, for example, voice commands.

It is appreciated that the present invention may be utilized with devices and systems coupled using technologies, standards, and/or communication protocols for both wireless and wired communication standards, including the IEEE 802.11 and Bluetooth wireless communication standards.

10           NETWORK CONNECTIVITY AND MOBILITY FOR A ROAMING CLIENT

The strategic solution here is to add new capabilities into an access point (AP). Each AP has information of its own IP address, subnet mask, and gateway information. A smart agent located at the AP is capable of sending the information to a client at appropriate times.

In one embodiment of the present invention, the connection status of an AP to its backbone network is provided to the clients associated with the AP by means of a smart agent and an associated protocol located and installed upon the AP. The effect of the invention is to provide a radically simple user experience in networking connectivity and mobility in both wired and wireless network infrastructures. The invention provides an improved mutual information exchange protocol between clients and APs in a dynamic networking environment.

For example, in one embodiment of the present invention, each time when a client associates with a new AP, the AP sends the information as described above to the client. The client then can smartly decide if it needs to renew its own IP address,

5 subnet mask, or Gateway settings. When a client associates with (or connects to) an AP, the AP initiates communications back to its associated clients regarding the AP's own network status prior to establishing connections of the client to the backbone network. In another embodiment, the AP only initiates

10 communication with the newly associating client to provide information, such as network status to the client.

In a wireless network the AP acts as a bridge between the client and the backbone network, and the AP sends to any

15 newly associated wireless client the AP information packet containing its network status.

In another embodiment, the smart agent also broadcasts to every associated client when events occur such as when its

20 backbone link is lost or its IP address has changed. The hub/switch at the AP provides capability to monitor the link status of the AP to the backbone network, and if applicable also captures TCP/IP information. For example, the smart agent may generate message frames according to any occurring

25 event in the hub/switch, such as a disconnection of an AP from the backbone network, or a change in the IP address of an AP. In a hub that does not require IP address,

information can still be provided for the client's network status diagnostics.

Within the scope of the invention, the client receiving  
5 the information will recognize that there is change in status  
of its associated AP. It might indicate to the client that  
the AP has lost or regained its backbone link or the AP has a  
new IP address, or the occurrence of other events. The  
client can then update its configuration accordingly, or roam  
10 to another available AP.

Within an embodiment of the invention, an example of the  
protocol specification that accompanies the Smart Agent is  
shown in Figure 3. The protocol is comprised of a layer 2  
15 protocol whose purpose is to exchange information between a  
client and an AP. The protocol resides in layer 2 so as to  
notify clients before the layer 3 network of the client is  
enabled. The protocol defines a new Ether-Type in the packet  
frame so it does not have to be in the payload of any  
20 existing layer 3 protocol (i.e. IP, IPX,...). This approach  
minimizes the dependency of the client to a specific protocol  
stack. The network information of an AP such as "backbone  
link status", "IP address", "network traffic statistics", and  
AP loading can be included in this protocol.

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A sample packet format as shown in Figure 3 illustrates  
the example protocol. Information such as network status, or

status of the connection to the backbone network, is shown in line 310. Information such as IP address type is shown in line 315, and the IP address in line 320. Line 325 of Figure 3 shows the IP address mask. Line 330 shows the IP gateway 5 of the access point.

Figure 4 depicts a flow chart 400 for providing network connectivity and mobility for a roaming client, in accordance with one embodiment of the invention. The network status

10 information can be used by the clients to update its configuration accordingly, or for the client to take the necessary action, such as reconnecting to the backbone network when an AP's connection to the backbone network is down.

15 Flow chart 400 begins with step 410 where an AP is enabled with smart agent capabilities and associated protocol. In step 410, within these smart agent capabilities are comprised the capability to automatically and continually monitor the AP link status to the backbone, and where applicable the capability to 20 capture the TCP/IP information. For example, within the protocol are comprised the backbone link status, the IP address, network traffic statistics, the AP loading information, as well as other pertinent information.

25 Next, in step 420, the AP has the capability to recognize a change in its network status in relation to the backbone network. For example, as discussed previously, the connection

to the network may be down, or the IP address of the AP may have changed.

If there is a change in AP's network status, then in step 5 425, the AP informs all associated clients of any and all AP configuration and/or status changes upon occurrence of those changes. For example, the changes indicated may be that the AP has lost or regained its backbone connection and/or that the AP has a new IP address including any changes of subnet, or the 10 information included within the protocol in Figure 3. The smart agent may generate message frames according to any event in the hub/switch, i.e. the AP. The AP then goes back to automatically and continually monitoring its network status in step 410.

15 Correspondingly, in step 430 of flow chart 400, the AP has the capability to recognize when there is a newly associating client. For example, a client may have roamed into the network of the AP, or the client is booting up within the area of the AP network. If there is a newly associating client, then in step 20 435, the AP sends its network status information to the newly associating client when the client associates with or connects to the AP. For example, the AP in a wireless network sends its AP information packet, such as that of Figure 3, to the newly associated client. The AP then goes back to automatically and 25 continually monitoring its network status in step 410

While the methods of embodiment illustrated in flow chart 400 show specific sequences and quantity of steps, the present invention is suitable to alternative embodiments. For example, not all the steps provided for in the method are required for 5 the present invention. Furthermore, additional steps can be added to the steps presented in the present embodiment.

Likewise, the sequence of steps can be modified depending upon the application.

10       The instructions for the steps, and the data input and output from the steps of flow chart 400 may be implemented utilizing processor 101 and ROM memory 103 and RAM memory 102, as shown in Figure 2. Furthermore, other types of memory storage can be utilized to accomplish the aforementioned such as 15 a hard drive.

Hence, the present invention provides an apparatus and method for monitoring network connectivity to a communication network, especially for a roaming client that goes from one 20 subnet to another subnet. Also, the present invention provides an apparatus and method that achieves the above accomplishment and which also provides a information exchange protocol between clients and access points in a dynamic networking environment.

25       The preferred embodiment of the present invention, a method and system for providing network connectivity and mobility for a roaming client, is thus described. While the

present invention has been described in particular embodiments, it should be appreciated that the present invention should not be construed as limited by such embodiments, but rather construed according to the below claims.